

BIOLOGICAL CONTROL: PLANT PATHOGENS

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That there is a 'biological balance'¹ among numbers and kinds of organisms in nature is clearly recognizable. The level of pesticide usage, especially in our modern practice of monoculture, tends to upset this balance and may even worsen pest problems. Agriculturalists have often succeeded, knowingly or unknowingly, in tapping this balance by a particular practice and have achieved a measure of disease control. Agricultural scientists are now actively pursuing predictable means to achieve biological control. Biological control of plant pathogens can be regarded as the action of one organism (humans excluded) or group of organisms to maintain a pathogen at a lower destructive population density than would occur in their absence. This definition may be applied to the following example: An avocado grower in Australia uses manures (animal and green plant), limestone, and superphosphate in his grove. As a result, the soil is rich in organic matter, high in calcium, and slightly acid in pH. The soil also contains organisms which are diverse and antagonistic to *Phytophthora cinnamomi* Rands, the causal agent of avocado root rot (2,3). Even though the pathogen is present and conditions are proper for disease development, the incidence of avocado root rot in this grove is very low, because the multiplication of the pathogen is suppressed (2,3,4). Surrounding groves in which these cultural practices are not followed suffer heavy losses due to avocado root rot because soil conditions differ, and they do not have the antagonistic organisms (2,3).

Soil and soil mixes for the most part contain a diverse array of organisms including pathogens and antagonists to these pathogens. The question is then, how can one eliminate pathogens and still retain some organisms that are antagonistic to re-introduced plant pathogens? The following experiment by Olsen and Baker (11) suggests an answer: Shallow flats about 20 cm² were filled with a soil that originally had a natural infestation of *Pythium* spp. and had been subsequently treated at 100 C, 71 C, and 60 C for 30 minutes, and not heat-treated. Treatment at 100 C (212 F) was accomplished by passing steam through these soils; treatments at 71 C (160 F) and 60 C (140 F) were accomplished by passing a mixture of steam and air (aerated steam) through these soils. The cooled flats were heavily seeded with *Capsicum* sp. (pepper). After the seedlings were established, a small uniform quantity of *Rhizoctonia solani* Kuehn was placed in the lower left corner of each flat as indicated in Fig. 1. The *Pythium* spp. were eliminated by treating the soil at 60 C for 30 minutes. However, this treatment did not eliminate the antagonistic organisms. Disease suppression was superior to the 71 C and 100 C treatments and was almost equal to that afforded by natural, untreated soil. *R. solani* introduced into steam-treated soils (100 C for at least 30 minutes) will proliferate because it is being introduced into a 'biological vacuum.'

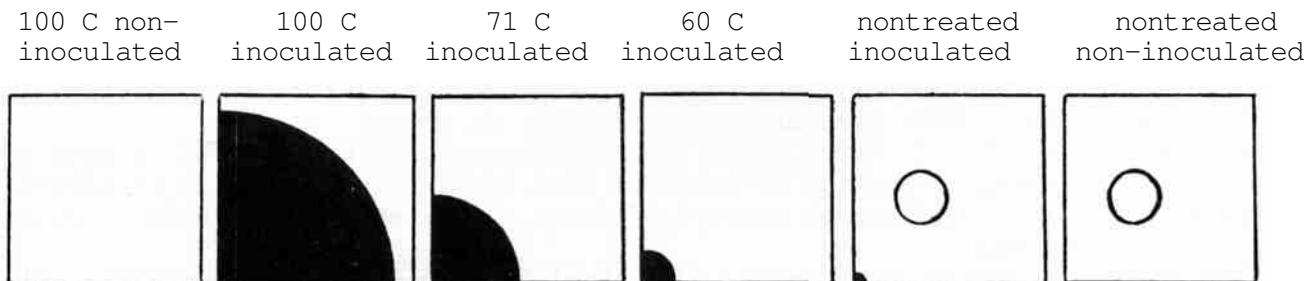


Fig. 1. Diagram of the relative occurrence of damping-off of pepper seedlings caused by *Rhizoctonia solani* (shaded areas). The soil was naturally infested with *Pythium* spp. (circles) which also caused damping-off. This diagram is similar to one presented by Baker and Cook (2) who used the data of Olsen and Baker (11).

Soil treatment in Florida's nurseries is either accomplished by methyl bromide fumigation or by steaming at 100 C. Very few, if any, nurseries in Florida use aerated steam. Inoculation of fumigated or steamed soils with a standardized set of antagonists to protect against re-introduced pathogens is a possibility. The difficulties of this procedure are that organisms have a degree of specialization for different soils and pathogens, and that they must be mutually compatible among themselves (1). This is a most difficult attainment, and a standardized set of antagonists has yet to be realized.

A recent report by Hoitink et al. (6) indicates that composting of hardwood bark that is initially infested with 4 fungal pathogens and one bacterial pathogen appears to eliminate the pathogens. Damping-off of tomato seedlings was more severe in a *Pythium ultimum* Trow infested peat mix than in a *P. ultimum* infested composted bark mix (10). The severity of a *Fusarium* wilt of chrysanthemum was less in the pathogen infested composted bark mix than in a similarly infested peat mix (5). Thus, there are indications that the finished compost may not only tend to eliminate the pathogen, but that it may also be suppressive to introduced pathogens.

Biological control of crown gall on peaches was reported by Kerr (7) in Australia. The bacterium, *Agrobacterium tumefaciens* (E.F. Sm. & Towns.) Conn is the causal agent of crown gall. Control was achieved with a closely related bacterium, *A. radiobacter* (Beijerinck & Van Delden) Conn by dipping roots of young peach seedlings into the antagonist (*A. radiobacter*) or by seed inoculation with the antagonist. Moore (9) in Oregon and Holler and Schroth (8) in California using *A. radiobacter* obtained spectacular control of crown gall on 5 species of stone fruits. Holler and Schroth (8) concluded that under normal cultural practices, treatment with this biological agent might provide 100 percent control. H. N. Hiller and J. W. Miller (unpublished information) in Florida observed a decrease in the incidence of crown gall on chrysanthemum cuttings when the *A. radiobacter* antagonist was applied.

There are many other examples of biological control that could be given. The interested reader is referred to a recently published book on biological control of plant pathogens by K. F. Baker and R. J. Cook (2). Biological control is a reality that has come of age. Biological control may not supplant traditional methods of control, but it can in many cases be integrated with them.

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